March, 2002

TO: Members, Washington State Board of Health

FROM: Washington State Department of Health
Newborn Screening Program

REGARDING: NEWBORN SCREENING, 2000 INFORMATION

The following information is presented to the Board in compliance with Chapter 246-650 Washington Administrative Code (WAC): Newborn Screening, as amended in October 1990. Section 246-650-040 directs the Department of Health to report to the Board annually:

- The results of each category of tests, by county of birth and ethnic group.
- Follow-up procedures and the results of such procedures.
- The costs of tests as charged by the Department.

To introduce this year's report we have again included a schematic overview of newborn screening and an informational overview developed by the March of Dimes.

Information on newborn screening during 2000 and preliminary information on 2001 are presented in the attached series of tables and accompanying explanations. Data relating to all births were extracted from 2000 birth certificates by the Department's Center for Health Statistics. These data relate to live-birth occurrences within the state. Data relating to infants detected, infants screened, and costs were extracted from data routinely maintained by the Department.

The data exclude information relating to infants born at Madigan Army Medical Center, Oak Harbor Naval Hospital and Bremerton Naval Hospital in 2000. These military hospitals do not participate in Washington's Newborn Screening Program.

Tables I and II present information on "The results of each category of tests by county of birth and ethnic group." Table III is a special breakdown of the results of hemoglobin screening by the infant's race, as indicated on the newborn screening specimen form. Tables IV and V and the preceding narrative present information on "Follow-up procedures and the results of such procedures." Table VI presents information on "The costs of tests as charged by the Department."

Also included in this report is a summary of infants detected by the Newborn Screening Program in 2001 by county of birth and age of treatment.

In response to critical funding needs, the state legislature approved a new fee in 2000 to help support the specialty care clinics that provide services to children with PKU, congenital hypothyroidism (CH), congenital adrenal hyperplasia (CAH) and hemoglobinopathies. The fee is collected by the Department of Health Newborn Screening Program in conjunction with the charge for screening. The new fee is set at $3.50 per child screened.

Disorders Detected Through Newborn Screening: Abbreviations Used in the Tables

PKU **Phenylketonuria**; inability to metabolize the common amino acid phenylalanine due to lack of the enzyme phenylalanine hydroxylase. If untreated, PKU results in severe neurological and developmental damage. Treatment consists of a special diet low in phenylalanine. Affected infants develop normally with proper dietary control.

CH **Congenital hypothyroidism**; insufficient production of the thyroid hormone thyroxine due to malformation or malfunction of the thyroid gland. If untreated, CH results in severe neurological and developmental damage. Treatment consists of hormone replacement with synthetic thyroxine. Affected infants develop normally with proper treatment.

CAH **Congenital adrenal hyperplasia**; excessive production of andreogenic hormones due to lack of the enzyme 21-hydroxylase. If untreated, CAH can lead to an imbalance in the body's concentration of salts which in turn can rapidly lead to shock and death. CAH also causes excessive masculinization and extremely premature sexual maturation. Treatment consists of providing cortisol which normalizes hormone production. Proper treatment prevents death and stops the masculinization process. Affected females may require surgical correction of masculinized genitalia.

Hb **Hemoglobinopathies:**

SCD **Sickle cell disease**; a condition marked by a tendency for the blood cells to take on a sickle shape due to an abnormal structure of the hemoglobin molecule. The altered shape results in anemia due to shortened life span of the blood cells and impedes circulation, especially in capillaries. Children with sickle cell disease are highly susceptible to bacterial infections that can rapidly lead to overwhelming sepsis and death. Affected children are also vulnerable to rapid pooling of blood in their spleens (splenic sequestration) which can lead to death. Treatment consists of regular doses of penicillin to prevent infection and training parents to recognize splenic crisis. Proper treatment dramatically reduces infections and death.

Other **Significant hemoglobinopathies**; hemoglobin abnormalities, other than sickle cell disease, that have significant clinical consequences (for example, transfusion dependent thalassemia). These conditions generally don't require immediate treatment but early identification allows families to adjust to the diagnosis, anticipate the medical needs, and begin early treatment plans as necessary.

TABLE I
BIRTHS BY COUNTY OF OCCURRENCE
INFANTS DETECTED BY COUNTY OF RESIDENCE

COUNTY	2000 BIRTHS	2000 INFANTS DETECTED				ALL INFANTS
		PKU	CH	CAH	Hb	
Adams	470		1			1
Asotin	2					
Benton	2,812			1		1
Chelan	1,448					
Clallam	616					
Clark	4,765		2			2
Columbia	0					
Cowlitz	1,320		1			1
Douglas	1					
Ferry	9					
Franklin	690					
Garfield	0					
Grant	1,076	1				1
Grays Harbor	490					
Island[a]	238					
Jefferson	160					
King	26,683	1	8	2	16	27
Kitsap[a]	1,731					
Kittitas	312		1			1
Klickitat	178					
Lewis	646					
Lincoln	20					
Mason	291					
Okanogan	530					
Pacific	61					
Pend Oreille	93					
Pierce[a]	8,682	1			6	7
San Juan	11					
Skagit	1,538					
Skamania	2					
Snohomish	5,719	1	1	1	1	4
Spokane	6,485	1	3			4
Stevens	274					
Thurston	2,813		1		2	3
Wahkiakum	0					
Walla Walla	837	1				1
Whatcom	2,050	1		1		2
Whitman	370					
Yakima	4,112	2	2			4
TOTAL[a]	**77,535**	**9**	**20**	**5**	**25**	**59**

[a] Excludes infants born in military hospitals that do not participate in the Newborn Screening Program (1,728 born at Madigan Army Medical Center, 431 born at Oak Harbor Naval Hospital and 769 born at Bremerton Naval Hospital). Total excluded = 2,928.

TABLE II
BIRTHS AND INFANTS DETECTED BY INFANT'S RACE

INFANT'S RACE[a]	2000 BIRTHS	2000 INFANTS DETECTED				ALL INFANTS
		PKU	CH	CAH	Hb	
White	61,071	8	10	5	0	23
Black	4,558	0	2	0	7	9
Asian	7,138	0	4	0	14	18
Native American	2,314	0	1	0	0	1
Other[b]	2,454	1	3	0	4	8
TOTAL	**77,535[c]**	**9**	**20**	**5**	**25**	**59**
Hispanic[d]	13,884	2	5	0	3	10

[a] The infant's race for 2000 is from birth certificate data and was determined by an algorithm of mother and father's race developed by the National Center for Health Statistics. The race of infants detected is from information provided on the newborn screening test form.

[b] Includes multiracial (more than one race designation on the screening form) or unknown (no designation made).

[c] Excludes infants born in military hospitals that do not participate in the Newborn Screening Program (1,728 born at Madigan Army Medical Center, 431 born at Oak Harbor Naval Hospital and 769 born at Bremerton Naval Hospital). Total excluded = 2,928.

[d] Hispanics can be of any race; they are included in the figures above.

Explanation and Key to Table III

Hemoglobins are by far the most complex of the conditions detected by Newborn Screening. More than a dozen genes are involved in hemoglobin production and nearly 700 abnormalities have been described by researchers and clinicians. Also, a variety of combinations are possible for any individual. Many of the abnormalities are rare and most have no clinical implications. A primary objective of our program is to identify those infants with sickle cell disease because these infants will suffer far less illness and death if they are promptly entered into a comprehensive health care program that includes prophylactic treatment with penicillin.

Phenotype	**Most Likely Genotype/Clinical Implications**
FSS	Homozygous for hemoglobin S. Results in sickle cell anemia, a severe form of sickle cell disease.
FSC	Hemoglobin SC disease. A moderate to severe form of sickle cell disease.
FSA	Hemoglobin S in combination with β-thalassemia[1] minor. A moderate form of sickle cell disease.
FEA	Hemoglobin E in combination with β-thalassemia[1] minor. A moderate to severe hemolytic anemia.
FAA+CS+ High Bart's	Two hemoglobins (Constant Spring and Bart's) indicative of multiple α thalassemia[2] genes. Likelihood of Hemoglobin H disease, a moderate to severe hemolytic anemia.
FAA + High Bart's	High level of hemoglobin Bart's indicative of multiple α thalassemia[2] genes. Likelihood of Hemoglobin H disease, a moderate to severe hemolytic anemia.
FCA	Hemoglobin C in combination with β-thalassemia[1] minor. A mild to moderate hemolytic anemia.
FCC	Homozygous for hemoglobin C. Mild hemolytic anemia.
FEE	Homozygous for hemoglobin E. Mild anemia.

[1] Decreased production of β globin chains; benign to severe anemia Significant interaction with other β chain variants such as hemoglobin S, E, and D.

[2] Decreased production of α globin chains; benign to severe anemia depending on how many of the four α globin genes are affected.

Phenotype	**Most Likely Genotype/Clinical Implications** (continued)
FAS+Bart's	Hemoglobin S trait in combination with α thalassemia[2]. No clinical implications for S trait (see FAS, below). Benign to mild anemia due to thalassemia.
FAE+CS+Bart's FAE+Bart's	Hemoglobin E trait in combination with α thalassemia[2]. No clinical implications for E trait (see FAE, below). Benign to mild anemia due to thalassemia.
FAC+Bart's	Hemoglobin C trait in combination with α thalassemia[2]. No clinical implications for C trait (see FAC, below). Benign to mild anemia due to thalassemia.
FA+Var+Bart's	Unidentified hemoglobin variant trait in combination with α thalassemia[2]. Clinical effects due to variant uncertain. Benign to mild anemia due to thalassemia.
FAA+Bart's	α thalassemia[2]. Benign to mild anemia.
FAS	Hemoglobin S trait. No clinical implications for child. Family may be at risk for sickle cell disease.
FAE	Hemoglobin E trait. No clinical implications for child. Family may be at risk for homozygous E or hemoglobin E/β-thalassemia[1], a significant hemoglobin disease.
FAC	Hemoglobin C trait. No clinical implications for child. Family may be at risk for homozgyous C, a mild to moderate hemolytic anemia or hemoglobin SC, a moderate to severe form of sickle cell disease.
FAD	Hemoglobin D trait. No clinical implications for child. Homozygous state is benign, however, family may be at risk for hemoglobin SD, a moderate to severe form of sickle cell disease.
FA+Var	Unidentified variant trait. Clinical effects unlikely.

[1] Decreased production of β globin chains; benign to severe anemia. Significant interaction with other β chain variants such as hemoglobin S, E, and D.

[2] Decreased production of α globin chains; benign to severe anemia depending on how many of the four α globin genes are affected.

TABLE III
NEWBORN HEMOGLOBIN SCREENING
Infants Detected by Phenotype and Race/Ethnicity
January through December 2000
Number of Infants = 77,535

PHENOTYPE	TOTAL	WHITE	BLACK	ASIAN	NAT. AM.	OTHER[a]	HISPANIC[b]
FSS	4	0	4	0	0	0	0
FSC	2	0	1	0	0	1	0
FSA	2	0	2	0	0	0	0
FEA	12	0	0	1	0	0	0
FAA + CS + High Bart's	1	0	0	1	0	0	0
FAA + High Bart's	15	0	0	12	0	3	1
FCA	6	1	2	0	0	3	1
FCC	1	0	1	0	0	0	0
FEE	20	0	0	17	0	3	0
FAS + Bart's	19	4	10	1	0	4	1
FAE + CS + Bart's	1	0	0	1	0	0	0
FAE + Bart’s	36	0	1	24	0	11	1
FAC + Bart's	1	0	1	0	0	0	0
FA + Var + Bart's	5	3	1	0	0	1	1
FAA + Bart's	782	186	156	169	4	267	71
FAS	364	62	165	4	1	132	60
FAE	187	13	1	110	1	62	11
FAC	83	11	42	0	0	30	9
FAD	30	21	0	2	0	7	9
FA + Var	156	102	9	9	3	33	36
TOTAL	**1727**	**403**	**396**	**351**	**9**	**557**	**201**

[a] Includes multi-racial (more than one race designation on the screening form) or unknown (no designation made)

[b] Hispanics can be of any race; they are included figures to the left.

Newborn Screening Follow-Up Procedures

All specimens that are determined to be presumptive positive through Washington's Newborn Screening Program are followed up immediately through direct telephone contact with the child's physician. This is to ensure that diagnostic testing and treatment, if indicated, is initiated as quickly as possible. Following a definitive diagnosis a long-term, disease-specific medical management program is implemented as follows:

Phenylketonuria (PKU) - Children are seen monthly in Seattle and every other month in Spokane by the Department of Health (DOH) subsidized University of Washington PKU clinic. An interdisciplinary team consisting of a pediatric metabolic physician, nutritionists, social worker and genetic counselor work closely with each family to optimize the child's dietary compliance through intensive education and support services. Periodic neuropsychological assessments are also provided for all patients to monitor cognitive and emotional development. For adults with PKU, consultative, support and nutritionist management services are provided at the University of Washington Division of Metabolism and Nutrition. Critical reproductive counseling and maternity services for Maternal PKU are also available.

Congenital Hypothyroidism (CH) - Thyroid hormone therapy is monitored by the child's primary health care provider and/or pediatric endocrinologist. The DOH subsidized CH Developmental Evaluation Clinic at the University of Washington (with an outreach clinic in Spokane) provides developmental, neuropsychological and occupational therapy assessments for affected children. In addition, parent educational meetings are held by DOH.

Congenital Adrenal Hyperplasia (CAH) - All children are seen for a diagnostic work-up by a pediatric endocrinologist to establish appropriate steroid hormone therapy. Long-term management is monitored by the child's primary health care provider and/or pediatric endocrinologist. Affected females with genital abnormalities related to the disorder are referred for surgical consultation. In addition, parent educational meetings are held by DOH.

Sickle Cell Disease (SCD) - Affected children are administered prophylactic penicillin and folic acid. Their long-term management is provided by a pediatric hematologist or an interdisciplinary team consisting of a pediatric hematologist, nurse, social worker and genetic counselor at a Comprehensive Sickle Cell Clinic (Children's Hospital Odessa Brown Center (Seattle) or Mary Bridge Children's Center (Tacoma). The Clinic staff work closely with each family to optimize the child's health and well-being through intensive education and support services. Periodic neuropsychological assessments are also provided for all patients to monitor cognitive and emotional development. Other sickle cell disease program components include a sickle cell summer camp and a support group through the Metropolitan Seattle Sickle Cell Task Force.

TABLE IV
INFANTS DETECTED BY FOLLOW-UP STATUS

FOLLOW-UP	2000 INFANTS DETECTED					ALL INFANTS
	PKU	CH	CAH	Hb SCD	Hb Other	
Followed by medical specialist - (i.e. pediatric endocrinologist, hematologist or comprehensive clinic). Compliant with treatment.	9	17	5	8	4	43
Followed by primary health care provider, with some consultation from specialist.	0	3	0	0	7	10
Lost to follow-up.	0	0	0	0	6 [a]	6
TOTAL	**9**	**20**	**5**	**8**	**17**	**59**

[a] Made recommendations for follow-up to primary health care provider for five infants, received no feedback regarding action taken.

TABLE V
INFANTS DETECTED BY AGE TREATMENT BEGAN

DISORDER		NUMBER OF INFANTS	AGE TREATMENT BEGAN (DAYS)	
			AVERAGE	RANGE
	PKU	9	10[a]	6 – 17
	CH	20	12[b]	7 – 20
	CAH	5	4[c]	2 – 7
Hb	SCD	8	46	13 – 115
	Other	17	n/a	–

[a] Excludes three infants with mild forms of PKU who did not require immediate treatment.

[b] Includes two infants who were detected only after their second screen, but excludes four infants with mild forms of CH who did not require immediate treatment.

[c] Excludes one infant who had a mild form of CAH that did not require immediate treatment .

TABLE VI
COST OF SCREENING PER INFANT DETECTED

	2000		AVERAGE	
DISORDER	RATE	COST	RATE[a]	COST[b]
PKU	1:8,615	67,200	1:13,174	102,750
CH	1:3,877	36,250	1:3,634	33,980
CAH	1:15,507	143,130	1:15,765	145,510
SCD	1:9,692	90,720	1:8,917	83,470

The price charged for newborn screening was $35.75 (there was no change in the screening charge from the previous year). State Law (RCW 43.20B.020) restricts this charge to no more than the "cost of the service provided." The charge includes direct and indirect costs necessary to administer the program. The average costs per child screened are broken down as follows: PKU: $7.80; CH: $9.35; CAH: $9.23; Hemoglobins: $9.36. This is a one time charge for each child, and covers the initial screening specimen and any others necessary to establish the infant's status including the routine second specimen collected at the first well-baby checkup at 7 - 14 days of age. These are the costs for screening, they do not include costs for clinical care of affected infants.

[a] AVERAGE RATE is the prevalence of the disorder among Washington newborns since the beginning of the program.

[b] AVERAGE COST is what it would have cost to detect an affected child at the average rate in 2000.

2001 WASHINGTON NEWBORN SCREENING
Infants Detected by County of Birth and Age at Treatment

In 2000 approximately 77,000 infants were screened by the Washington State Newborn Screening Program. This represents over 99% of the babies who meet the criteria for screening and excludes approximately 3,000 infants born at three Washington military hospitals that do not participate in Washington's Newborn Screening Program.

DISORDER	NO. INFANTS BY COUNTY		AGE TREATMENT BEGAN (DAYS) AVERAGE	AGE TREATMENT BEGAN (DAYS) RANGE
Phenylketonuria (PKU)	Clark	2	9[a]	6 – 17
	King	6		
	Pierce	2		
	Statewide Total	**10**		
Congenital Hypothyroidism (CH)	Benton	3	13[c]	7 – 38
	Clallam	3[b]		
	Grant	1		
	King	6		
	Mason	1		
	Pierce	1		
	Skagit	1		
	Snohomish	3		
	Spokane	2		
	Thurston	2		
	Yakima	1		
	Statewide Total	**24**		
Congenital Adrenal Hyperplasia (CAH)	Adams	1	4[d]	3 – 7
	Cowlitz	1		
	Pierce	1		
	Snohomish	1		
	Thurston	1		
	Walla Walla	1		
	Statewide Total	**6**		
Sickle Cell Disease (SCD)	Clark	1	34	14 – 50
	King	1		
	Pierce	3		
	Yakima	1		
Other Significant Hemoglobinopathies	King	7	n/a	–
	Pierce	2		
	Snohomish	2		
	Statewide Total	**17**		

[a] Excludes two infants with mild forms of PKU who have not yet required treatment.

[b] Set of triplets.

[c] Includes two infants who were detected only after their second screen, but excludes four infants with mild CH who did not require immediate treatment.

[d] Excludes one infant with a mild form of CAH who did not require immediate treatment .